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I, JANENE PEISKER, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2002952619 for a patent by THE UNIVERSITY OF SOUTHERN QUEENSLAND as filed on 13 November 2002.



WITNESS my hand this  
Twenty-sixth day of November 2003

A handwritten signature in black ink, appearing to read 'J. Peisker'.

JANENE PEISKER  
TEAM LEADER EXAMINATION  
SUPPORT AND SALES

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## **PROVISIONAL SPECIFICATION**

Invention Title: "POLYMER CONCRETE"

The invention is described in the following statement:

TITLE

"POLYMER CONCRETE"

FIELD OF THE INVENTION

5 This invention relates to polymer concrete. In particular, the invention resides in polymer concrete that is used to produce structural elements.

BACKGROUND OF THE INVENTION

10 Developments in civil engineering and the building industry have created a continual demand for building materials with new and improved performance attributes. Polymer concretes appear to offer possibilities for meeting these new requirements.

15 Polymer concrete consists of aggregates bonded together by a resin binder instead of a water and cement binder that is used in standard cement concrete. Polymer concrete has generally good durability and chemical resistance and is therefore used in various applications such as in pipes, tunnel supports, bridge decks and electrolytic containers. The compressive and tensile strength of polymer concrete is generally significantly higher than that of standard concrete. As a result polymer concrete structures are generally smaller and significantly lighter than  
20 equivalent structures made out of standard concrete. Additional advantages of polymer concrete include very low permeability and very fast curing times.

The biggest disadvantage of polymer concrete is its cost. Resin is significantly more expensive than cement and water and to be cost effective resin content is generally reduced as much as possible. However, it

is the resin that binds the aggregates together and gives the polymer concrete its strength. Polymer concrete with a low resin content generally results in a brittle product with low tensile strength. Further, the resin content also determines the overall viscosity of the polymer concrete formulation.

5 Polymer concrete with a low resin content is generally very dry and difficult to work with.

As with standard concrete, the gradation of the aggregate for polymer concrete is based on the particle size of the different aggregate components. The particle size of the different aggregate components is  
10 chosen such that maximum packing of the overall aggregate is obtained. This maximum packing results in a minimum amount of remaining voids within the overall aggregate which have to be filled with resin. Hence maximum packing results in the minimum amount of resin that is required in the polymer concrete formulation.

15 A limitation of traditional polymer concrete is that it is very difficult to get a controlled variation of structural properties throughout a specific product. Many structural products have specific areas that require high compression strength and other areas that require high tensile strength.

As with standard concrete, polymer concrete structures often  
20 require reinforcement. Traditional steel reinforcement bars can be used, but as polymer concrete is often used in corrosive environments, continuous fibre composite reinforcement is generally preferred. Most continuous fibre composite reinforcement relies on adhesion between the polymer concrete and the reinforcement to transfer forces. In dry polymer concrete

formulations there is often not enough resin in the mix to achieve the necessary level of adhesion and hence the fibre composite reinforcement has to be provided with a physical anchorage such as ribs. As most continuous fibre composite reinforcement is produced using the pultrusion process, incorporation of ribs or another forms of physical anchorage is difficult and expensive.

#### OBJECT OF THE INVENTION

It is an object of the invention to overcome or alleviate one or more of the disadvantages of the above disadvantages or provide the consumer with a useful or commercial choice.

It is a preferred object of this invention to enable polymer concrete to be produced with a controlled variation of the density throughout the final product.

It is a further preferred object of this invention to enable polymer concrete to be produced with a controlled variation of the resin content throughout the final product.

It is a still further preferred object of the invention to enable polymer concrete to be produced with a controlled variation of structural properties throughout the final product.

It is a still further preferred object of the invention to enable polymer concrete to be produced with controllable flowability and excellent workability.

It is a still further preferred object of the invention to enable polymer concrete to be produced cost effectively.

It is a still further preferred object of the invention to allow structural elements made of polymer concrete to be produced with a significantly reduced weight.

#### SUMMARY OF THE INVENTION

5 In one form, although not necessarily the only or broadest form, the invention resides in a polymer concrete formulation comprising:

an amount of polymer resin;

an amount of a light aggregate with a specific gravity less than that of the resin; and

10 an amount of a heavy aggregate with a specific gravity larger than that of the resin.

The resin may be any suitable polyester, vinylester, epoxy or polyurethane resin or combination of resins dependent on the desired structural and corrosion resistant properties of the polymer concrete.

15 Preferably the resin content is between 25-30% by volume.

The light aggregate with a specific gravity less than that of the resin can be any type of light aggregate or combination of light aggregates dependent on the desired structural and corrosion resistant properties of the polymer concrete. Usually, the light aggregates have a specific gravity of 0.5 to 0.9. The light aggregates usually make up 20-25% by volume of the polymer concrete. Preferably the light aggregate are centre spheres. The centre spheres normally has a specific gravity of approximately 0.7 Alternately, hollow glass microspheres with a similar specific gravity and volume may be used.

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The heavy aggregate with a specific gravity larger than that of the resin can be any type of heavy aggregate or combination of heavy aggregates dependent on the desired structural and corrosion resistant properties of the polymer concrete. The heavy aggregates usually make up  
5 40-60% by volume of the polymer concrete. Preferably the heavy aggregate is basalt. Usually the basalt is crushed. The crushed basalt may have a particle size 5 to 7 mm. Preferably the basalt makes up between 40-50% by volume of the polymer concrete. The basalt normally has a specific gravity of approximately 2.8. Alternately, sand that has a similar specific gravity as  
10 basalt may be used. Preferably the sand makes up between 50-60% by volume of the polymer concrete.

Preferably the resin contains a thixotrope to keep the light aggregate in suspension.

The polymer concrete of the present invention may also include  
15 fibrous reinforcement material to increase the structural properties of the polymer concrete mix. The reinforcement material may be glass, aramid, carbon and/or thermo plastic fibres.

In another form, the invention resides in a method of forming a structural element using polymer concrete, the polymer concrete having an  
20 amount of polymer resin, amount of a light aggregate with a specific gravity less than that of the resin; and an amount of a heavy aggregate with a specific gravity larger than that of the resin, the method including the steps of:

choosing an amount of resin;

choosing an amount of light aggregate to obtain the desired viscosity of the resin-light aggregate mix

choosing an amount of heavy aggregate to form a desired thickness of a lower layer within the structural element;

5                    mixing the resin, heavy aggregate and light aggregate together to form polymer concrete;

                    locating the polymer concrete in a mould;

                    allowing the polymer concrete to settle to form a lower layer and an upper layer of different consistence within the structural element;

10                   removing the structural element from the mould.

                    Reinforcement members may be located within the polymer concrete after the polymer concrete has settled. The reinforcement member may be located in the upper layer of the structural element.

#### BRIEF DESCRIPTION OF THE DRAWINGS

15                   An embodiment of the invention will be described with reference to the accompanying drawings in which:

                    FIG. 1 is a perspective view of a marine beam produced in accordance with the invention;

                    FIG. 2A is a front view showing the first step in producing the  
20                   marine beam of FIG. 1.

                    FIG. 2B is a front view showing the second step in producing the marine beam of FIG. 1.

                    FIG. 2C is a front view showing the third step in producing the marine beam of FIG. 1.



FIG. 2D is a front view showing the fourth step in producing the marine beam of FIG. 1.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a marine beam 10 formed using polymer concrete 20, flat composite fibre reinforcing members 30 and tubular composite fibre reinforcing members 40.

The polymer concrete 20 is formed with approximately 28% by volume of resin, 22 % by volume of light aggregate and 50% by volume of heavy aggregate.

The light aggregate is in the form of centre spheres having a specific gravity of approximately 0.7 The heavy aggregate is formed from crushed basalt having a specific gravity of approximately 2.8 and a particle size of 5-7mm.

The light aggregate has a specific gravity that is slightly less than that of the resin whilst the heavy aggregate has a specific gravity that is larger than that of the resin.

A thixotrope is added to the resin so that the light aggregate will stay in suspension within the resin. Consequently, the resin together with the lighter aggregate in suspension becomes a flowable filled resin system in its own right. The amount of the lighter aggregate suspended in the resin can be varied as required. To obtain an economical polymer concrete formulation the lighter aggregate is approximately 45% by volume of the flowable filled resin mix.

The heavy aggregate, which is heavier than the resin, will sink

to the bottom of the polymer concrete and can as such be positioned in certain parts of the final product. By adding the heavier aggregate in specific amounts during the pour, layers or areas of polymer concrete with different amounts of aggregate and hence different density and structural properties can be obtained.

FIGS 2A to 2D show the process that is used to produce the marine beam 10 shown in FIG. 1. The first step in the process is to produce formwork of a desired shape to form a mould 50. In this example, the marine beam 10 is produced in an upside down manner.

Polymer concrete is mixed and poured into the mould and allowed to sit. The heavy aggregate settles out in the bottom of the mould. The amount of aggregate is chosen such that once the aggregate has settled, a lower aggregate layer 60 will stop approximately 10mm below the surface of the polymer concrete. Consequently there is a 10mm upper layer 61 of resin and light aggregate on top of the lower layer 60 of the polymer concrete that is aggregate rich. Because there is no heavy aggregate in the upper 61 layer, the resin content in this layer is 56% by volume and the light aggregate in suspension in this layer is 44% by volume.

Individual flat fibre composite reinforcement members 30 and tubular fibre reinforcement members 40 are then located in the mould in the upper layer. The resin and light aggregate of upper layer 60 surrounds the flat reinforcement members and the tubular composite reinforcement members as shown in FIG. 2C. This resin and light aggregate of the upper layer provide excellent adhesion for the tubular fibre composite

reinforcement bars.

Additional polymer concrete is then added to the mould as shown in FIG. 2D. The heavier aggregate again settles on top of the tubular reinforcement elements to form a lower layer 70, leaving a thin upper layer 71 of the filled resin mix near the top of the mould 150. The upper layer 71 is then screeded without interference of the heavy aggregate that is not located within the upper layer. The polymer concrete is then allowed to cure and the marine beam is removed from the mould 10.

The marine beam has high compressive strength areas where there is a high heavy aggregate content and high tensile strength areas where there is increased resin content together with reduced aggregate loading. In this manner, the structural properties can be varied throughout the marine beam to achieve a desired structural result.

It should be appreciated that the techniques used to produce the variations in structural properties for the marine beam maybe used on other structural elements.

It should be appreciated that various other changes and modifications may be made to the embodiment described without departing from the spirit or scope of the invention.

DATED this Twelfth day of November 2002.

THE UNIVERSITY OF SOUTHERN QUEENSLAND

By its Patent Attorneys

FISHER ADAMS KELLY

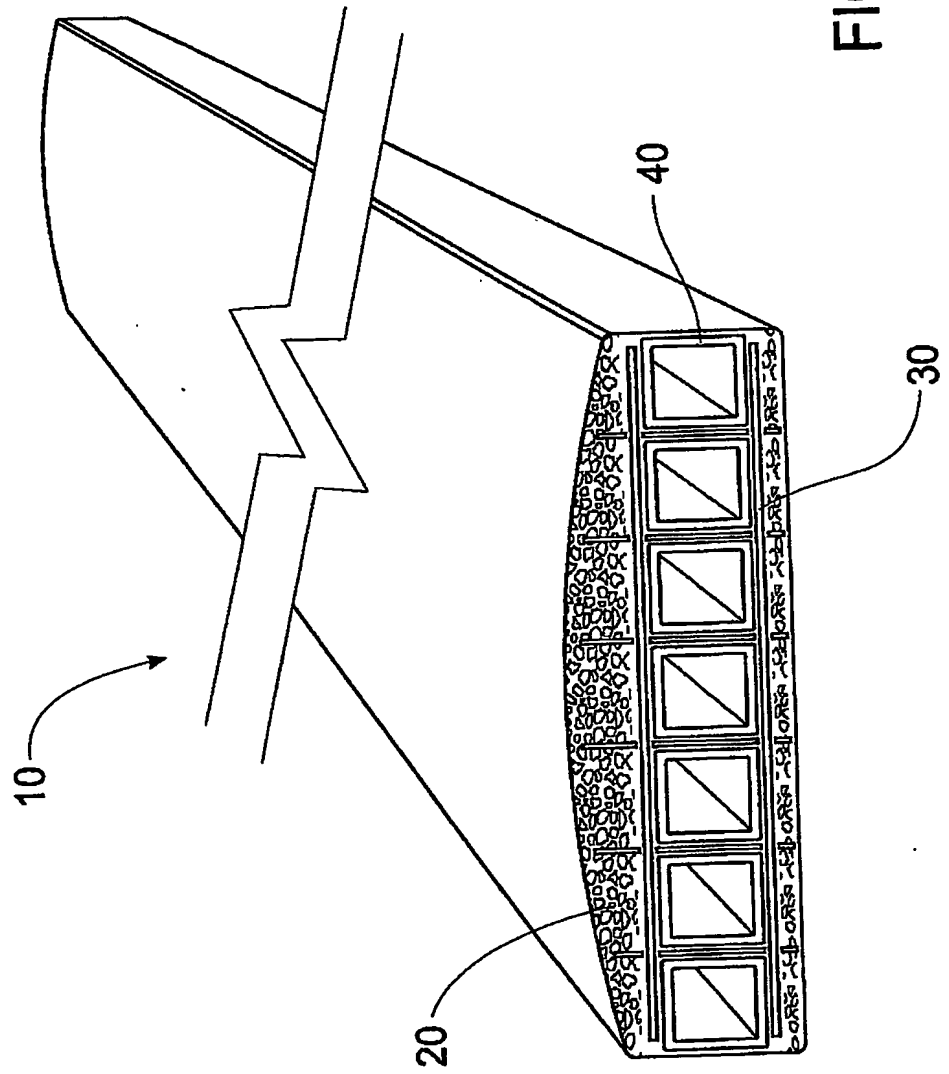


FIG. 1

2 / 2

